LSAH

THE LONGITUDINAL STUDY OF ASTRONAUT HEALTH

Newsletter

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Prevalence of Hypertension in LSAH Participants

Blood pressure is the force of the blood pushing against the walls of arteries. It is measured in millimeters of mercury (mmHg), and given in two numbers. The higher number indicates systolic pressure, which is the amount of force exerted on the walls of arteries within and leading from the heart when it contracts (*i.e.*, during systole). The lower number is the diastolic pressure, which is the force existing between contractions (*i.e.*, during diastole).

Blood pressure continually varies to meet the ever changing needs of the body and is normally regulated very tightly by the brain. The body's demand for oxygen is low at rest so the brain lets the pressure fall to a lower level. During exercise a greater supply of blood is required and the pressure goes up. Surges of blood pressure are thus quite normal during either mental or physical activity. Normal blood pressure is usually considered to be 120/80 mmHg; measurements above 140/90 mmHg are considered to be hypertensive. Hypertension, or high blood pressure, simply refers to the increased tension or pressure in the arteries. Hypertension is a major risk factor for heart attack, heart failure, stroke, and kidney failure. Most hypertensive people have no symptoms.

For most people, there is no single known cause of high blood pressure. This type of high blood pressure is called primary or essential hypertension. Essential hypertension can't be cured, although in most cases it can be controlled. In some cases, high blood pressure can be traced to a known cause like tumors of the adrenal gland, chronic kidney disease, hormone abnormalities, use of birth control pills, or pregnancy. This is called secondary hypertension, and is usually cured if the underlying cause passes or is corrected.

Classification of hypertension by its severity is somewhat arbitrary, because there's no precise level of pressure above which it suddenly becomes dangerous. The traditional view of the risks associated with high blood pressure was that diastolic pressure was the most important. Several more recent studies, mostly conducted in people over the age of 50, have shown that systolic pressure is a better predictor of

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What is Epidemiology?

The Longitudinal Study of Astronaut Health (LSAH) follows epidemiological principles in examining basic medical data to determine whether the unique occupational exposures encountered by astronauts are associated with increased health risks. However, the concept of epidemiology and how it determines the association between exposure and health risks is not immediately obvious to many people. The following is a brief description of the concepts of epidemiology and how they are applied to LSAH.

Elements of epidemiology

Epidemiology can be described as "a branch of medical science that deals with the incidence, distribution, and control of disease in a population" or as the "study of the distribution and determinants of disease frequency in human populations". Three elements of epidemiology emerge from these definitions. The first is frequency: how often a particular disease is found within a population. The second element concerns the distribution of the disease: who gets it, when, and where they get it. From these two elements the third one, determinants, can be derived. By describing the patterns of the disease, possible causal and/or preventive factors may be determined. Over time, the concept of epidemiology has been broadened to include the study of chronic diseases (*e.g.*, cardiovascular disease) along with the original study of infectious diseases. Refinements in epidemiological methods were subsequently developed to reflect the less clear cut causal relationship between a host of factors over a long induction period and the chronic disease, as compared to the relationship between a pathogenic microorganism and an infectious disease.

Association *vs.* causation

Causation is only one out of four possible explanations for the outcome of the exposure; the other three are bias, confounding and chance. Bias is the systematic error in collecting or interpreting data, and

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Diabetes Among the LSAH Participants

State of the art medical and technological advancements have resulted in increased life expectancies worldwide. These advancements have also shifted the major causes of illness and death from infectious diseases — those caused by microorganisms — to chronic diseases— those of slow progression and long duration. Diabetes is one of such chronic diseases of major concern to the medical community due to its sixfold increase from 1958 to 1997 and annual total cost of $98 million. Diabetes is a group of disorders of carbohydrate metabolism. It results in an inadequate production or utilization of insulin, which is essential to maintain the body's proper blood sugar level. Symptoms include but are not limited to frequent urination, excessive thirst, unexplained weight loss, or extreme hunger. Complications may include blindness, high blood pressure, amputations, or disease of the heart, kidney or nervous system.

In 1997, diabetes was ranked as the seventh leading cause of death in the United States with an abundance of 60,000

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is minimized through the study design. For example, recall bias can occur when study participants are asked for their last recorded blood pressure; many participants may not be able to remember that value. Confounding happens when a third factor, while associated with exposure, is also a risk factor for the disease independent of the exposure. An example of this is the confounding factor of age in the association between increased physical activity and a decreased risk of myocardial infarctions. Those who are physically active tend to be younger; at the same time, younger individuals have a lower risk of myocardial infarction than older ones, regardless of their physical activity status. Minimizing of confounding is also done through study design. The third explanation, chance, is measured through statistical testing. The result of this statistical testing is given by a p-value, which is the probability that the outcome arises from chance alone, assuming that there is no association between exposure and disease. By convention, a probability of 0.05 or less leads to rejection of chance being the explanation of the disease, and hence rejection of the hypothesis of no association between exposure and disease. Note that statistical significance does not necessarily confer biologic importance to the results. A sound epidemiological study aims to minimize the contribution of bias, confounding and chance to the outcome so that a causal relationship becomes a valid explanation for the outcome. Even then, valid results of more than a single study are needed before causality between an exposure and a disease can be established.

LSAH study design

LSAH compares incident rates of diseases/disorders of the astronauts to that of comparison participants to determine whether astronaut occupational exposures lead to increased diseases/ disorders rates. Because of the nature of the astronaut program, some unavoidable differences exist in the amount and kind of medical information collected between the astronaut and comparison participants. Therefore, care is taken to compare only those data that are collected under similar conditions for each of the two groups to minimize bias. Matching of the comparison participant group to the astronaut group in some demographic variables helps reduce the role of confounding factors in comparing the health outcomes of both participant groups. Finally, the role of chance as the explanation for the outcome is evaluated through the appropriate statistical testing when comparing the data between astronauts and comparison participants.

We hope that this brief explanation of the basic principles behind LSAH is helpful in better understanding the study results presented in this newsletter and other publications. ■

Test Your NASA/JSC Knowledge

1. When did the Johnson Space Center (JSC) open?
2. Who was the first director of JSC? Who is the current director?
3. Who was the first U.S. astronaut to orbit the earth?
4. How many buildings are there at JSC?
5. What is the name of the rocket in Rocket Park? What was it used for?
6. How many NASA affiliated astronauts have been selected to the Astronaut Corps?
7. How many NASA Centers are there?
8. What are the names of the four Space Shuttle Orbiters currently in use?
9. What is the name of the astronaut band?

Answers:

1. 1963
2. Robert R. Gilruth. George W. S. Abbey
3. John Glenn
4. 119
5. Saturn V. It was used to transport the Apollo astronauts to the moon.
6. 295
7. 16
8. Columbia, Discovery, Atlantis, Endeavour
9. Max Q

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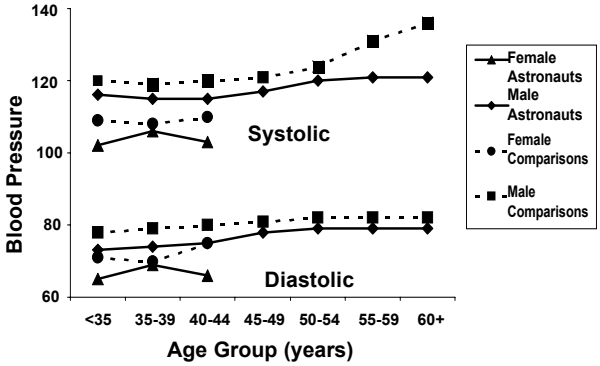
risk of strokes and cardiovascular disease than diastolic pressure. It has also been reported that pulse pressure (the difference between systolic and diastolic pressures) may be the best predictor of all; people who had the largest pulse pressure were at highest risk of strokes. These findings suggest that it is better for people with high systolic pressure to have a correspondingly high diastolic pressure than a low diastolic pressure.

Figure 1. Sitting Blood Pressure - Mean Values by Age

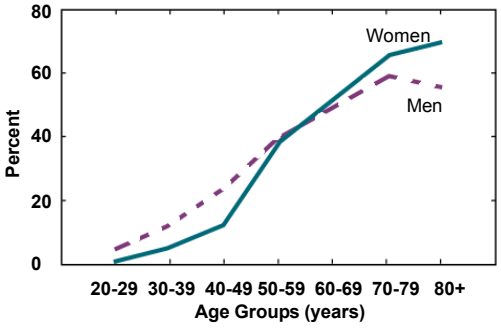


Most cases of hypertension can be controlled through lifestyle changes, such as maintaining a healthy body weight, limiting sodium and alcohol intake, and increasing aerobic exercise. For others, lifestyle changes are not enough, and one or a combination of medication(s) is needed to control their hypertension.

According to data from the third National Health and Nutrition Examination Survey conducted from 1988-1991 (NHANES III), 20.4% of the US adult population are hypertensive (defined as systolic pressure of at least 140 mmHg or diastolic pressure of at least 90 mmHg). Annual examination data for active and inactive NASA astronauts between 1959-1999 show 5.5% of them (21 of 291) have been diagnosed with hypertension. In comparison, data from the annual examinations of comparison participants over a similar time period show 13.9% (121 of 870) had corresponding hypertension diagnoses. As physical fitness is a requirement for astronauts, they are expected to show a lower rate of hypertension as compared to the general population. The comparison participants had more than double the hypertension rate of the astronauts, but still had a lower rate than the general population. This lower rate of hypertension may be an effect of being a healthy working population.

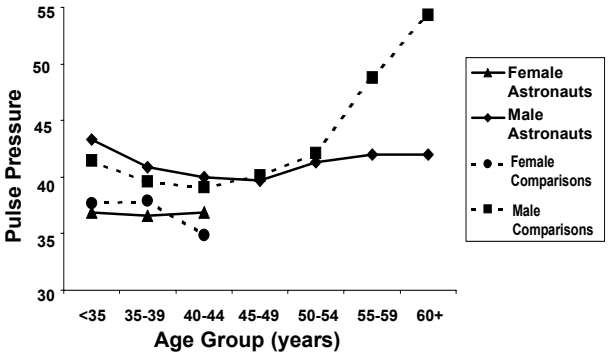
Cross-sectional data of LSAH participants by age group (Figure 1) show that most of them have average systolic pressure around or below 120 mmHg. Up to age 49, male comparisons show the same trend of systolic pressure measurements, although with slightly higher values, with that of the male astronauts. Male comparison participants aged 50 and older showed a higher increase of their systolic pressure as compared to male astronauts aged 50 and older. The diastolic pressure measurements for the male comparisons do not show a corresponding upward trend. Although the highest average measurement from the oldest age group of male comparisons is still below the hypertensive value of 140 mm Hg, this trend follows one observed in the general population. Data from NHANES III show that the highest increase in hypertension prevalence occurs between the 40-49 and 50-59 years age group for men (Figure 2). The small sample size of female participants does not allow for age group comparisons beyond the 40-44 age group.

Figure 2. Prevalence of Hypertension by Sex and Age, United States 1988-1991



SOURCE: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health and Nutrition Examination Survey III (Phase I).

Figure 3. Pulse Pressure - Mean Values by Age



When the same values are used to obtain pulse pressure (Figure 3), male comparison participants age 50 and older show sharply increasing measurements. This increase in pulse pressure, coupled with the increasing average systolic pressure mentioned above indicate that male comparisons age 50 and older face a higher risk of heart and kidney diseases, or stroke compared to the other participant groups.

In general, LSAH participants have lower prevalence of hypertension than that observed for the US adult population. This probably reflects better fitness of the astronaut group, and the healthy worker effect of the comparison group as compared to the general population. However, on closer examination, male comparisons age 50 and older show increasing average systolic pressure and pulse pressure readings. This particular participant group may find it prudent to monitor their lifestyle factors to counter this trend towards hypertension. ■

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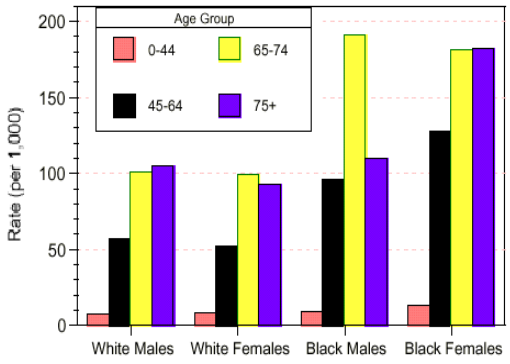
attributable deaths. Over 16 million people in this country are estimated to have the condition with an estimated 800,000 cases expected to be newly diagnosed per year. A disproportionate number of cases occur in minority populations, women, and the elderly (Figure 1).

Figure 1. Age-specific Prevalence of Diagnosed Diabetes by Race and Sex, United States 1992-1994



Source: Diabetes Surveillance, 1997

The four basic types of diabetes include:
Type 1 diabetes, formerly known as insulin-dependent diabetes mellitus or juvenile-onset diabetes, makes up 5 to 10% of all diagnosed cases. It usually occurs abruptly in individuals less than 30 years of age. Risk factors include autoimmune, genetic, and environmental factors.
Type 2 diabetes, formerly known as non-insulin dependent diabetes mellitus or adult-onset diabetes, makes up 90 to 95% of all diagnosed cases. It usually occurs gradually in individuals 40 years and older. Risk factors include increasing age, obesity, family history, impaired glucose tolerance, and sedentary lifestyles.
Gestational diabetes occurs in 2 to 5% of all pregnancies and typically resolves after the pregnancy. Risk factors include family history and obesity.
The remaining diagnosed cases are due to a variety of conditions including genetic syndromes, surgery, drugs, malnutrition, infections, and other illnesses.

The American Diabetes Association recommends three methods of diagnosing diabetes: (1) symptoms of diabetes and a plasma glucose concentration >200 mg/dl, (2) a fasting plasma glucose (FPG) level >126 mg/dl, or (3) a 2 hour plasma glucose level of >200 mg/dl during an Oral Glucose Tolerance Test. A positive test should be followed by a repeat test on a different day. Testing should be considered for individuals 45 years of age and older as well as younger individuals if they exhibit any of the risk factors. Treatment plans are based on the individual's needs and the specific type of diabetes; however, they generally consist of a prescribed combination of a carefully controlled diet, physical exercise, home blood glucose testing, insulin injections, or oral medications.

Of the 252 active and inactive NASA astronauts receiving at least one physical examination from 1994 to 1998, four had a single FPG value within the range of diabetes diagnosis, but one inactive astronaut — who did not have an annual exam during this time — has been clinically diagnosed with diabetes. Of the 821 LSAH comparisons receiving physical exams within the specified time frame, 16 have been clinically diagnosed with diabetes. Although the prevalence of diabetes in the U.S. population is 5.9%, only 0.3% of the astronaut corps and 1.8% of the LSAH comparisons have diabetes.

Diabetes is becoming increasingly more common, costly, and complex. Clinical trials are being conducted to determine if types 1 and 2 can be prevented and if effective intervention programs can be established. Development of retinal disease has been demonstrated as early as 7 years prior to diabetes diagnosis. Consequently, early diagnosis and subsequent treatment may ultimately reduce the burden of diabetes and its complications. Additional information can be obtained by contacting the American Diabetes Association at 1-800-DIABETE or www.diabetes.org. ■

For your information

If you want a copy of your exam results, please complete and sign a release form while you are visiting the Clinic for your examination. The form is called *Privacy Act Disclosure Authorization and Accounting Record (DAAR)*, or NASA Form 1536.

...and ours

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